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CONTINUOUSLY VARIABLE MAGNET POWER SUPPLY

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INSTRUMENTATION

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INTRODUCTION:

The need for continuously scanning the mass spectra in the mass spectrometer has led to the development of a variable magnet power supply which will deliver from 0 to 500 milliamperes to a magnet of 1100 ohms resistance. The supply is a continuously variable, electronic, degenerative regulator which will regulate better than one part in 5000 throughout the range. Line voltage fluctuations of ± 10 volts have no effect on the output of the supply.

OPERATION:

The power supply is actually two electronic degenerative regulators. One of the circuits provides a constant voltage for the bias supply used in the main regulator. The positive side of the bias regulator is necessarily at ground potential to supply a negative bias for V_3 (See Figure 1). The grid of V_1 sees about one-half of any D.C. voltage change on the output of the bias regulator. Since the voltage gain of the 6SJ7 is about 400[1] when a 10 megohm plate load is used, a change of 1 millivolt in the output will cause a change of about 0.2 volts on the grid of the 6V6. This high gain combined with the adjustment of the proper screen potential on V_1 produces a 300 volt output in which there is no detectable ripple nor any detectable variation in D.C. level. The adjustment of this screen potential is made with an oscilloscope connected across the bias supply to detect the point of minimum supply fluctuation.

The regulator proper consists of six 807's in parallel to pass the magnet current. These tubes were selected because of their low cost and high voltage handling capacity. The average plate dissipation for each 807 is 10 watts with a maximum of 20 watts at full supply current of 500 milliamperes. At zero current, 800 volts appear across the 807's. The supply originally contained two 829's as series regulators, but difficulty was experienced when high frequency oscillations tended to develop due to the common screen grid connection in each tube. Also, these oscillations were probably due to the screen-to-cathode bypass capacitor built into the 829. A cost comparison also shows that six 807's cost less than one-half of the cost of two 829's.

The 807's are controlled by a 6SJ7 using a 10 megohm plate load. The output as observed on an oscilloscope shows no ripple and less than one millivolt fluctuation in the D.C. level. The supply can have either positive or negative regulation depending upon the adjustment of R_2.

The adjustment of the supply is as follows:

1. Connect magnet or inductive dummy load and oscilloscope across the supply output.

2. With R_4 set counter-clockwise, adjust R_3 for zero current.

3. Advance R_4 to full clockwise and adjust R_2 to allow load current of 500 milliamperes. (Caution: Care must be used in setting R_3 and R_2 since there are two possible adjustments of these controls. The wrong adjustment will be indicated by instability in supply output and the positioning of the contact arm of R_3 too near one end of the potentiometer.)

4. Return R_4 to its counter-clockwise position and readjust R_3 for zero current.

5. Repeat steps 3 and 4 until the range of 0 to 500 milliamperes is covered by the helipot control.

6. Connect a voltmeter to the supply output and note the voltage at 500 milliamperes output.

7. Break the connection between the supply and the load, and note the voltage change on the output voltmeter. If any change is observed, correct for the change by rotating R_2 a small amount. Continue this adjustment until a decrease of from 1 to 5 volts is noted in the 550 volt output when the load is placed on the supply.

8. The oscilloscope signal should show very little fluctuation at this point. Further minor adjustment of R_2 and R_3 may be necessary to obtain the best supply regulation.

An alternate method for supply adjustment can also be followed, i.e.:

1. Set R_4 midway between clockwise and counter-clockwise stops (5 turns).

2. Adjust R_2 and R_3 for best regulation as shown on an oscilloscope with an output current of between 220 to 270 milliamperes.

3. Adjust R_6 and R_7 for proper zero current position and full range of 500 milliamperes at maximum control position. (R_4)

The supply is constructed on two separate chassis as indicated by the separate schematic diagrams Figure 1 and Figure 2. Figure 2 is the diagram of the high voltage rectifier supply which has a D.C. output of 800 volts at 500 milliamperes. This high voltage is chosen to give the best possible regulation in the range in which the regulator is intended for use. This range is around a load current of 400 milliamperes. At this current, a voltage of 350 volts appears across the 807 regulators, and by experiment, the best regulation occurs between 200 and 500 milliamperes of load current. It was thought that it might be advisable to include a switch for cutting out 3 or more of the 807's for better regulation in the low current range. This idea was discarded because of the possibility of overload should the supply be run at high currents with the 807's out of the circuit. Regulation at low currents is more than adequate for stable operations of the mass spectrometer.

It is intended that this regulator be used with a motor driven potentiometer (R_4). The mechanism for driving the potentiometer was not completed at the time of the writing of this report. The heart of the drive will be a Brown 2-phase balancing motor to give variable speed and reversibility.

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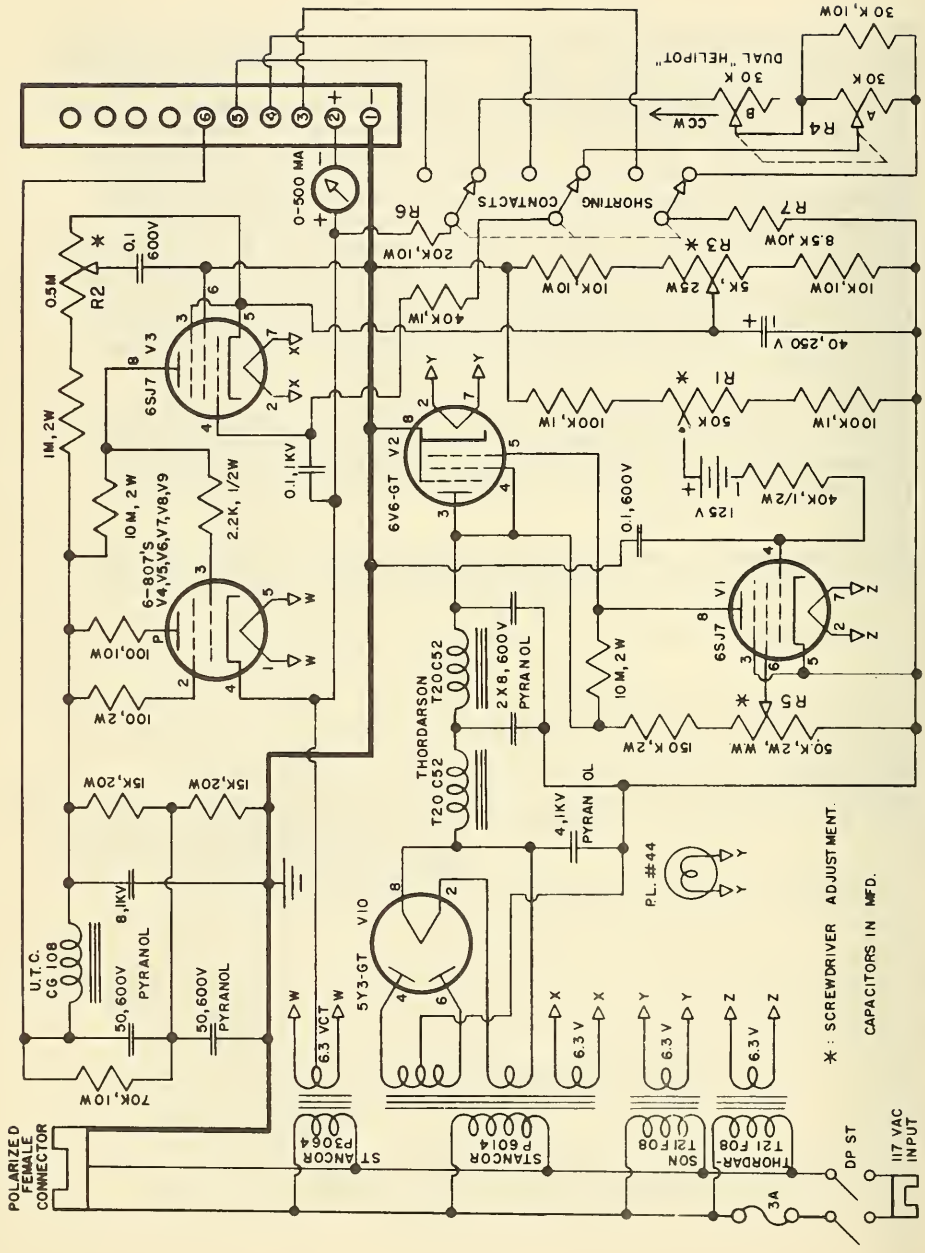

FIGURE 1. Continuously Variable MAGNET SUPPLY MAGNET CONTROL PANEL

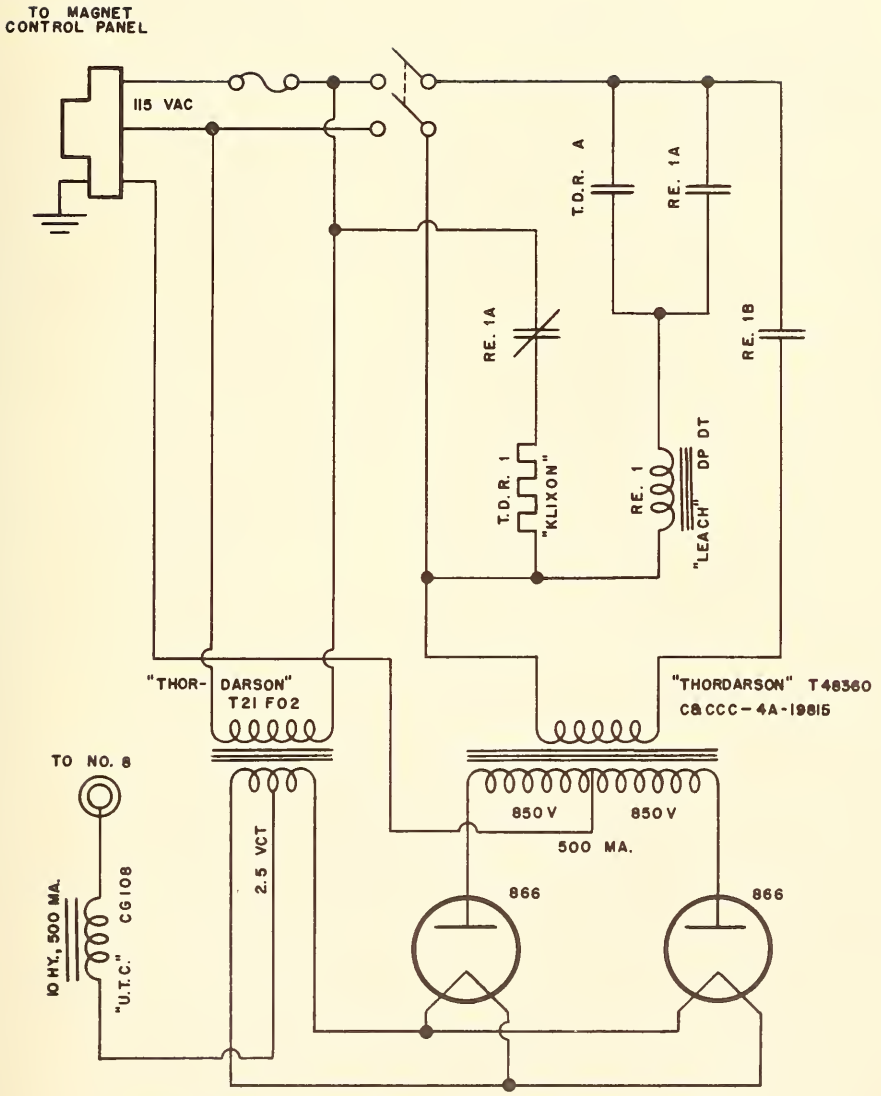

FIGURE 2. Continuously Variable MAGNET SUPPLY TRANSFORMER PANEL

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